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ABSTRACT

This article presents a rationale for incorporating reading activities with science. It emphasizes that science investigations can provide a background for, and an interest in, reading among students. Three approaches for using science as a vehicle for reading are given: (1) the unit approach; (2) the tradebook, activity card approach; and (3) the independent reading and investigation approach. A lengthy list of references related to integrating reading with science are given. (SA)

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SCIENCE AS A VEHICLE FOR READING

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Children are wonderfully curious about the natural world and this basic curiosity can be nurtured by science to establish a need to learn more. Science that appeals to young children is concrete and personal, and when presented as an active investigative experience, it heightens curiosity. The interest generated in a science topic can be used to encourage further investigation and simultaneously develop reading skills in gathering information and following directions.

Science is a natural for demonstrating the use of books as sources of knowledge. An ever increasing body of scientific knowledge makes it necessary to develop skills in using resources to answer questions and to expand understanding. Children cannot learn everything in science through discovery experiences. Consequently, the development of scientific literacy must rest, to a large extent, on the students' ability to read and understand appropriate materials. Our challenge becomes one of finding the proper balance of first-hand experiences and the use of reading materials to achieve the overall objectives of science teaching.

To paraphrase an old adage, a science book in the hand is worth two on the shelf. Establishing the motivation to use books and other reading resources is best accomplished by involving children in investigations that create as many questions as answers. When those questions can not be

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answered through further investigation, a need for an alternative source of information becomes clear. A purpose for using science books is thus established, and purposeful reading is almost always more successful than assigned reading.

Reading that stems from experience with a topic is likely to be more meaningful because it is known that what a child brings to reading affects what he gets from reading. When active experience in science preceeds reading, children will have the motivation to read as well as the background experience that will help them understand what they have read.

One of the best ways to introduce reading in science is for the teacher to model the use of science books in the context of investigation and discussion. This is particularly important for young non-readers because they need a model who values reading and who exhibits excitement and enthusiasm while reading. When skillfully done by the teacher, children learn to associate reading with pleasure, and a firm foundation for reading is established.

There are very few of us who can answer all the questions posed by children and it is important to show them how we find the answers to questions we do not know. Even when we know the answer to a particular question, it may be more valuable to help a child use a science resource to find the answer than to provide him with the answer. Children need to see that adults do not have all the answers and they too must learn. Much of teaching shows children what we have learned; they also should see how we learn.

Approaches to Integrated Science and Reading

In using science as a vehicle for reading there are at least three approaches that can be taken. These are the unit approach, the tradebook-activity card approach, and the independent reading and investigation approach.

A Science Unit with Associated Readings

In the unit approach, begin by selecting a topic from your science curriculum or one of particular interest to your students. Using the resources available, assemble a related collection of science tradebooks and other science readings. These should vary widely in both reading level and style.

Science source books, teachers' guides and science curriculum project materials can be used to gather ideas for science activities related to the chosen topic. These activities, experiments and investigations will provide both satisfaction from independent accomplishment and motivation to learn more. The specific ways the science readings are used in the classroom will vary according to teaching style but in every situation they should be readily available. The motivation to read science decreases as the distance to reading sources increases. Going to the library is not the answer; open access to a classroom set of high interest science books is.

High Interest Tradebooks with Activity Cards

Select a number of high interest science tradebooks on a variety of topics that will appeal to your students. For each book, design an ac-

companying activity card that will provide children with ideas for developing their vocabulary, practicing their reading comprehension skills, and applying, expanding and communicating what they have learned.

A good collection would consist of 10 to 15 books from which students might choose five or so to read during the school year. The element of choice is very important and this freedom should be incorporated into their use as part of your reading program.

Developing activity cards takes time, so start slow. Select a few books on topics that also interest you. Children's books, even those in science, can be easily read by an adult; keep one handy for those times you have a few spare minutes. As you read each book, make some notes for ideas in the suggested categories of vocabulary development, reading comprehension and follow-up application and communication activities.

Vocabulary development can be made fun through the imaginative use of games, puzzles and other challenging tasks. Enlisting the aid of your students or those in the upper grades will produce surprisingly creative ideas that you can use in the activity cards.

For the section of an activity card that I call, "Put on Your Thinking Cap," write interesting questions that require literal, inferential and critical reading skills to be applied to the narrative of the book. Although you would want to include questions that focus on ideas and information explicitly stated in the book, be sure that you also ask questions that encourage a child to extend on what has been read. Higher level comprehension questions require a child to go beyond explicitly stated ideas by asking for imagination and judgment. Learning to be a good thinker takes practice, and good questions asked in the

context of something that interests children will provide them opportunities for thinking.

In the third category, "Let's Try It," include suggested experiments and activities from the book or others you may know of from another source. Children also like to share what they have learned and suggested mini-projects will help them to demonstrate their new knowledge. While in the process of sharing, they also can be practicing skills in organization, writing, and creative expression.

With a little practice, the task of writing good activity cards becomes easier and before long you will have a fine collection for your students to use. Some suggested ideas for writing activity cards for children, as well as a sample card, are appended.

Tradebooks and Kits That Encourage Independent Investigation

Most children are highly motivated by science activities and experiments, and they particularly enjoy making discoveries on their own. This interest can be directed to independent science reading by providing children with science tradebooks that contain many suggested activities. The number of science tradebooks that encourage independent investigation has increased dramatically in recent years and encompass a broad range of topics. Examples of this type include MAGNIFY AND FIND OUT WHY, HOT AND COLD from the "Let's Try It Out" series, and SCIENCE FUN WITH A FLASHLIGHT. These books offer interesting and practical problems that are simple to investigate and of immediate value to a child.

Begin a collection by choosing as many or as few books as your resources allow. Review each book noting the materials that would be needed to conduct the suggested activities. Assemble the required materials in a small box, making substitutions for supplies and equipment as necessary, and create a procedure for the students to check out both the book and the box of materials.

This approach requires less development time but greater management time to insure the proper maintenance and replacement of the necessary materials. Additional information on management procedures is available in the article, "Operation Shoebox," (SCIENCE AND CHILDREN, April 1973). This article describes the use of the approach in a library, but many of the procedures are applicable to the classroom setting.

Although the major emphasis of these three approaches for using science as a vehicle for reading is on science tradebooks, other reading sources should not be overlooked. Science reading selections from textbooks and basal readers, as well as children's magazines, such as RANGER RICK and National Geographic WORLD, can play an important role in science/reading activities. Tables of content and yearly indexes can be used to identify appropriate selections and can also be used to develop children's skills in locating information in the context of a science unit that has captured their interest.

Sources of Children's Science Books

The science tradebooks you will need for integrated science and reading must be chosen carefully because they vary so widely in quality, accuracy and writing style. Fortunately, there are many resources available that

will help in the selection process, but ultimately the best source of appropriate books for your students is your own professional judgment. The time you spend in perusing the science book collections in school and public libraries will always be worthwhile. Visiting university curriculum laboratories, seeking the assistance of librarians and asking colleagues for their recommendations, will contribute to your skill in selecting the best science readings for your students.

The SUBJECT GUIDE TO CHILDREN'S BOOKS IN PRINT is particularly helpful in identifying the number of books available on a given topic. If there is an author of children's science books, whose work you admire, use the author's index of CHILDREN'S BOOKS IN PRINT to locate other books written by that author. Similar reference tools are also available in other languages. In Spanish, they include: FICHERO BIBLIOGRÁFICO HISPANO-AMERICANO; LIBROS EN VENTA EN HISPANOAMÉRICA Y ESPAÑA; and REVISTA INTER-AMERICANA DE BIBLIOGRAFÍA.

Numerous journals containing reviews of children's science books are also valuable as a selection tool. Among these are SCIENCE BOOKS, a quarterly published by the American Association for the Advancement of Science, SCIENCE AND CHILDREN, a publication of the National Science Teacher's Association, CHILDHOOD EDUCATION, TEACHER, PARENTS' MAGAZINE and THE READING TEACHER. Particularly noteworthy is the yearly March issue of SCIENCE AND CHILDREN that includes an annotated bibliography of outstanding children's science tradebooks published that year.

Other sources of information are publishers' catalogs. In some instances a separate catalog of their science books is available. A number of publishers also offer a science tradebook series, such as the

"Let's-Read-and-Find-Out" science books from Thomas Y. Crowell, the "Science I Can Read" books from Harper and Row, and the "First Library Series" from MacDonald Educational. Many "book jobbers," or wholesalers, also have collections of science books gathered from a variety of publishers on particular topics that they offer to schools as a package.

All of these resources for locating children's tradebooks in science are an aid and not a replacement for a teacher's best judgment. They are intended as a place to start, but only knowledgeable, well-read teachers can follow through on the sensitive and challenging task of finding the right books at the right time for their children.

Selection Criteria

Judging the overall quality of a science tradebook encompasses a large number of factors. Among the most important are readability and scientific accuracy. In reviewing books you should also ask yourself questions such as: does the book encourage children to think for themselves; are the suggested activities safe; is it free from sexual and racial bias; and are the concepts suitable for your students' age group? Factors related to physical qualities are inevitably important: is it durable; is the binding sturdy; are the illustrations clear; and do they complement the narrative?

Some awareness of readability is certainly necessary in order to select appropriate science readings. Numerous techniques exist for estimating reading level from "eyeballing it" to readability formulas. The least formal of these, eyeballing it, requires the grasp of certain variables when glancing through a book. Some of these are the size of

print, the length of sentences, the amount of narrative on a page, and the use of pictures. Considering the subjectivity involved in this procedure, the result is likely to be a rough estimate.

Many readability formulas are available and among the best known are the Dale-Chall, SRA, Flesch, and Fry. All of these consider the variables of vocabulary and sentence complexity, but the operational definitions, or ways they are measured, differ for each formula. Fry developed his method while in Uganda when time and simplicity were prime prerequisites for estimating reading difficulty. It is often recommended for use by classroom teachers because of its predictive accuracy and uncommon simplicity. The procedure consists of selecting three 100-word passages at random and counting both the number of syllables and the average number of sentences per 100 words. The resulting averaged values are plotted on a readability graph to determine the approximate reading level. The "true" level may be different due to other influencing factors such as style, organization patterns, numbers of concepts and the use of formula, symbols and graphic aids. In view of the complexities in estimating reading level, any readability score is most properly interpreted when it is taken to mean a point within a range of reading levels.

Although there is considerable controversy over readability measures, their use does provide a means for attending to some of the variables affecting reading level. Knowledge of these factors can contribute to a more thoughtful selection of readings - some more simply written; others more challenging. In this way, the reading levels of a variety of science books may accommodate a wide range of reading abilities.

Even when we feel comfortable with knowing the approximate reading level of a book, we often discover that what is readable for one student

may not be readable for another, although both are reading on the same general level. Ultimately, we are interested in how readable a particular book is for each individual child. When we speak of how readable a book is, what we really mean is how understandable it is to a student. The Cloze procedure is a test designed to accurately and quickly assess each student's ability to understand a reading selection. This method involves selecting a reading passage, deleting every fifth word and replacing those words with blanks of equal length until a total of 50 words have been omitted. The first and last sentences are left intact. Students are given copies and asked to fill in the blanks with the words they believe have been omitted. The completed papers are scored by determining percentage of correct answers. A score of 60 and above indicates an easy level, a score between 41 and 60 indicates a functioning level where teacher assistance may occasionally be needed, and a score of 40 and below indicates a frustrational reading level for the student (and the teacher, too). Although not practical for use with numerous tradebooks, it may be a useful procedure when applied to a science text that is frequently referred to as a source of information.

Estimating the readability of science materials will always be somewhat difficult. Polysyllabic words are common in science and may artificially raise the apparent reading level of the material. Many teachers view technical vocabulary as the most important factor contributing to the reading difficulty of science materials. Yet, there is considerable evidence that children have greater difficulty with non-technical vocabulary than they do with technical words. When unaware of this, teachers often concentrate on new scientific terms to the exclusion of other vocabulary.

Non-technical vocabulary includes both general and special words. General words are common words, but are often not in the vocabulary of young children, e.g. significance, encounter. Special words are those that take on a new meaning when used in a science context, e.g. bulb, cycle, multiply.

It would not be possible to locate and preteach all the difficult general and special words when using a variety of science tradebooks and other reading selections. However, reading lessons in contextual analysis and the study of words with many meanings should be incorporated into science/reading instruction.

Book reviews and annotated bibliographies, when coupled with our own understanding of the subject matter, are particularly helpful in determining the scientific accuracy of science books. Most reviewers would not recommend a book that is not scientifically accurate or readable by students of the age group for whom it was intended.

In applying criteria for selecting appropriate science books, one should consider the opinions of the children who will be using them. One way of gathering this information is by asking children to write a review of the book. Explain to the children that what you are requesting is not a book report, but rather their opinion of what they liked and disliked about the book they have chosen to review. When reading the children's reviews, look for differences in opinions as well as similarities. Preferred characteristics of books should be kept in mind when selecting future science tradebooks.

The following unedited reviews were written by fourth grade children when studying ocean life:

The book was interesting Not at all hard but Not to easy so I would not like it. It was very unstandable it was a good book. It was not too long and boring and the pictures were great. It told about snails, mussels and burnacles.

It was a graet book for geting facts. Even tho I did not read the hole thing I could tell it was good and the pictures are really good.

It was huge print and had neat information. It was easy to understand and it had good pictures. It is very short. I think it's a good book.

It (is) not a very good book because it just tell about the boy and girl (who) are saying stuff about the shell they found.

They have very good facts. And it was easy to read. The book was very good. The book was not to long.

Often children of varying reading abilities will have different preferences. All children like pictures, but they are particularly important to children with low reading ability. Good readers like books they can understand, but that are not too easy to read.

Children's purposes in reading will also affect their attitudes toward a book. When seeking a general overview of a topic, some children might prefer a book with a story line, while those looking for an answer to a specific question will find the narrative type of book too wordy. Knowing this, it is important to have a variety of books both in style and reading level that can be matched with the appropriate reader. Color coding the books according to level and type will help in directing a child to the right book.

When using science as a vehicle for redding, the major points to remember are to use reading when it is appropriate and not to overdo it to the exclusion of other ways of learning. Science and reading for young children work best together when science investigation provides

the background to and the interest in reading to find out more. Early and pleasant experiences with reading science materials can be the basis from which students build and maintain their scientific literacy through reading as an adult. If we foster the will to read and supply the opportunity for practice, we will open the doors to an amount of science far beyond that which was provided in school.

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VCU 79

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READING SCIENCE TRADEBOOKS
IDEAS FOR WRITING ACTIVITY CARDS FOR CHILDREN

New Words and Meanings

crossword puzzles
word scrambles (with hints, e.g. meanings)
draw what each word means to you
missing letters (e.g. can you find the missing vowel)
finding opposites of words using the tradebook
use the book to find words that mean...
write a poem about (topic in book) using these words
write a who am I riddle for each of these words
find these hidden words (make a letter grid)
label the parts of a drawing (blanks at each part, or use missing letter approach to make it easier)
say these words into the tape recorder
match the words that mean the same
find ten words that end in "s" and mean more than one
write a story using all these new words
use each word in a sentence
draw a (e.g. flower) and label the parts using these words
can you find some words that have a new meaning in this book?
these words have new meanings (special words) what did they mean to you before? what is their new meaning?

(this is just a partial list of vocabulary development ideas, can you come up with other ideas?)

Put on Your Thinking Cap!

Include interesting questions that require the child to think about what was read.

Literal comprehension - recall questions focusing on ideas and information explicitly stated in the book.

Reorganization comprehension - questions that ask the child to classify, summarize, or consolidate explicitly stated ideas and information

Inferential comprehension - questions that ask for thinking and imagination that goes beyond the explicitly stated ideas and information.

Evaluation - questions that ask the child to make judgement about what was read

Let's Try It!

Suggest experiments and activities from the book or related activities you have from another source

Suggest mini-projects to demonstrate what they have learned:
make a tape-recording of...
make a chart; a bulletin board; a mural; a model; a collage
write a story, play, a diary
take a walk and collect...
drawings, diagrams

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SAMPLE ACTIVITY CARD
for:

Ballob, Edward, City Leaves City Trees. New York: Charles Scribner's Sons, 1972.

New Words and Meanings

Which tree is it?

1. This tree has long, pointed leaves and drooping yellow branches that move with the wind.
2. This tree was once called the 'Holy Tree" because it was used in churches at Christmas time.
3. This tree has simple-opposite leaves and winter buds that sit on the ends of twigs like tiny mushrooms.
4. This tree has simple-alternate leaves that are lopsided with rough toothed edges.

Make a simple drawing of each of the following:

1. Simple leaf
2. Compound leaf
3. Smooth edge
4. Toothed edge
5. Lobed edge

Put on Your Thinking Cap

1. The Southern magnolia can grow only in sheltered places in the North. Why do you think this is so?

2. Why would you find lots of squirrels in a park with many beech trees?

3. How do you think the seeds of a maple tree get spread around? (Hing: see the picture on page 45)

Let's Try It!

1. If leaves are available (or use pictures), sort the leaves into groups of simple-alternate, simple-opposite and compound leaves.

   Can you sort them again by types of edges? Try it.

2. Open up tree buds (Dogwood is good) and find the little flowers inside.

3. Soak some cloves in water to soften them; cut them open - what can you see?

4. Use the identification key, beginning on page six, and identify some leaves.